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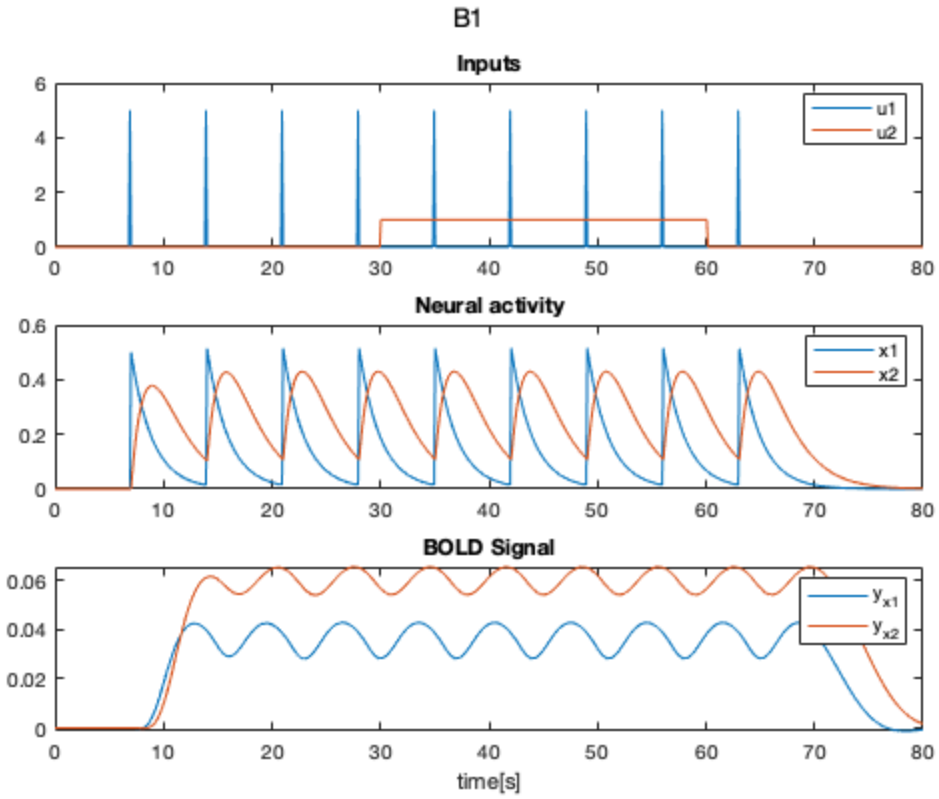
```
clear all;
close all;
```

B1

```
%If B = B1 = 0, the dynamics of the neural system are independent of
 the
%modulatory input. Descriptively we see that x1 and x2 are periodic
 and
%u2=1 has no influence on them.

index = 1;
b_vector= linspace(-1,1,5);

for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];

    %construct u
    u_vector = zeros(2,800);
    u_vector(2,301:601)= 1;
    u_vector(1,70:70:631)=5;

    % hrf model construction

    %hemodynamic state vector at t=0 (s,f,v,q)
    h0 = [0;1;1;1];

    % prameters for hrf : kappa, gamma, tau, alpha and E_0
    Phrf=[0.64,0.32,2,0.32,0.4];

    % compute dcm
    [y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);


    % plot results
    t = linspace(0,80,800);
    figure;
```

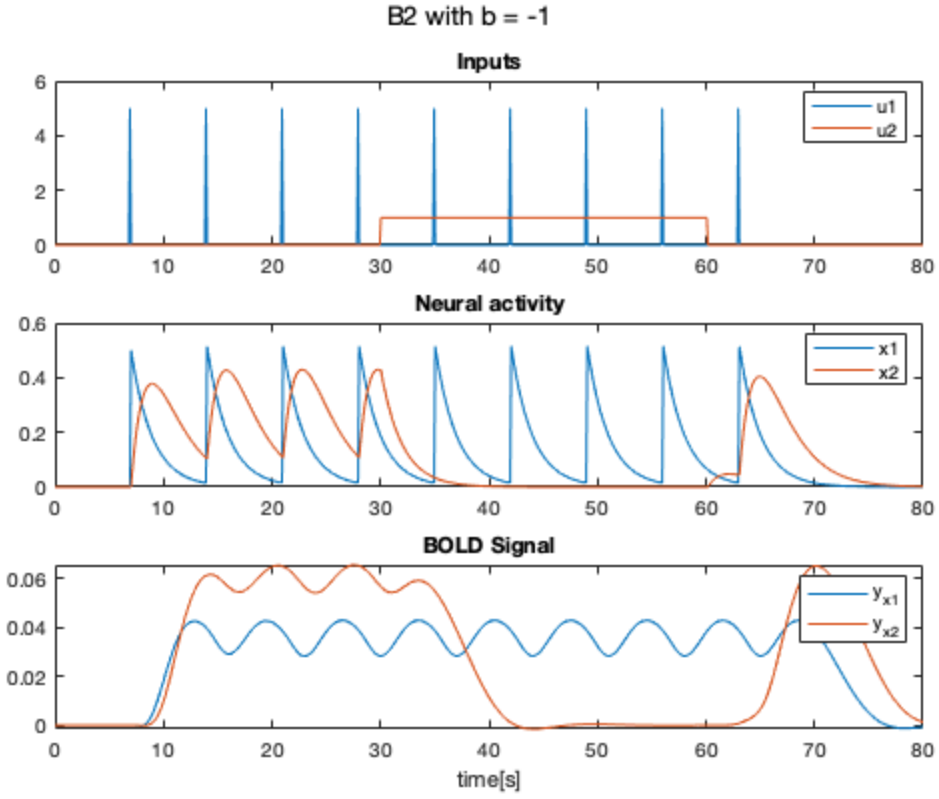
```
    subplot(3,1,1);
    plot(t,u_vector(:,:));
    ylim([0,6]);
    title('Inputs')
    legend('u1','u2')

    subplot(3,1,2);
    plot(t,x(:,:));
    %ylim([0,0.6]);
    title('Neural activity')
    legend('x1','x2')

    subplot(3,1,3);
    plot(t,y(:,:));
    %ylim([0,0.08]);
    title('BOLD Signal')
    legend('y_{x1}','y_{x2}')
    xlabel('time[s]')


    if(index == 1)
        sgtitle(['B',num2str(index)])
        break;
    else
        sgtitle(['B',num2str(index), ' with b =
 ',num2str(b_vector(j))])
    end
end
```

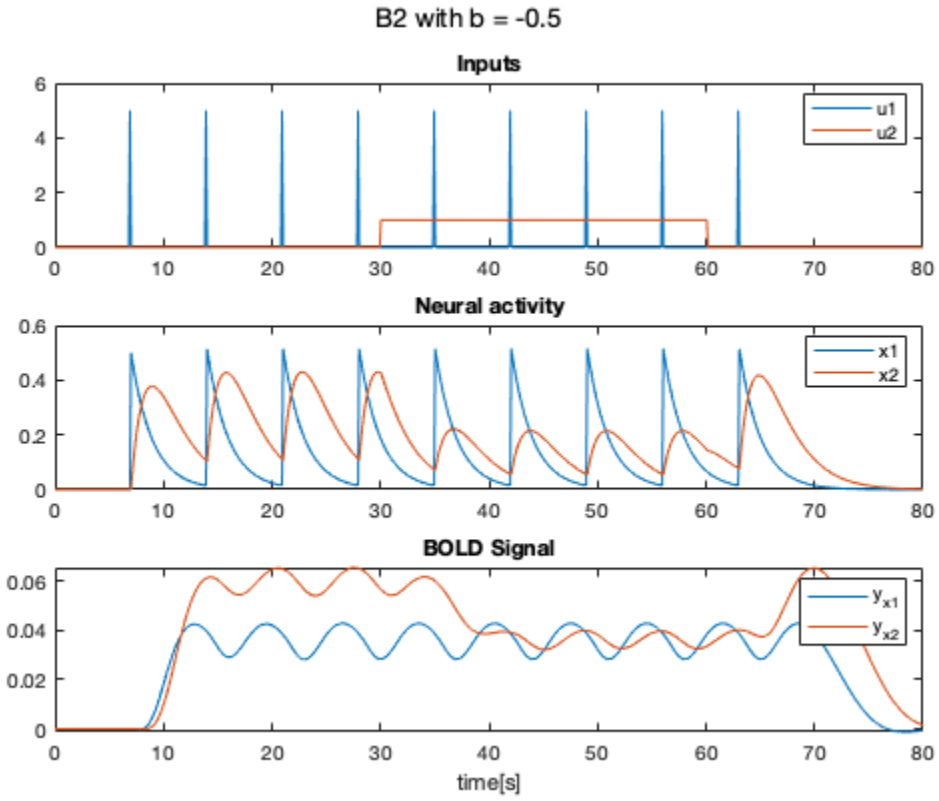


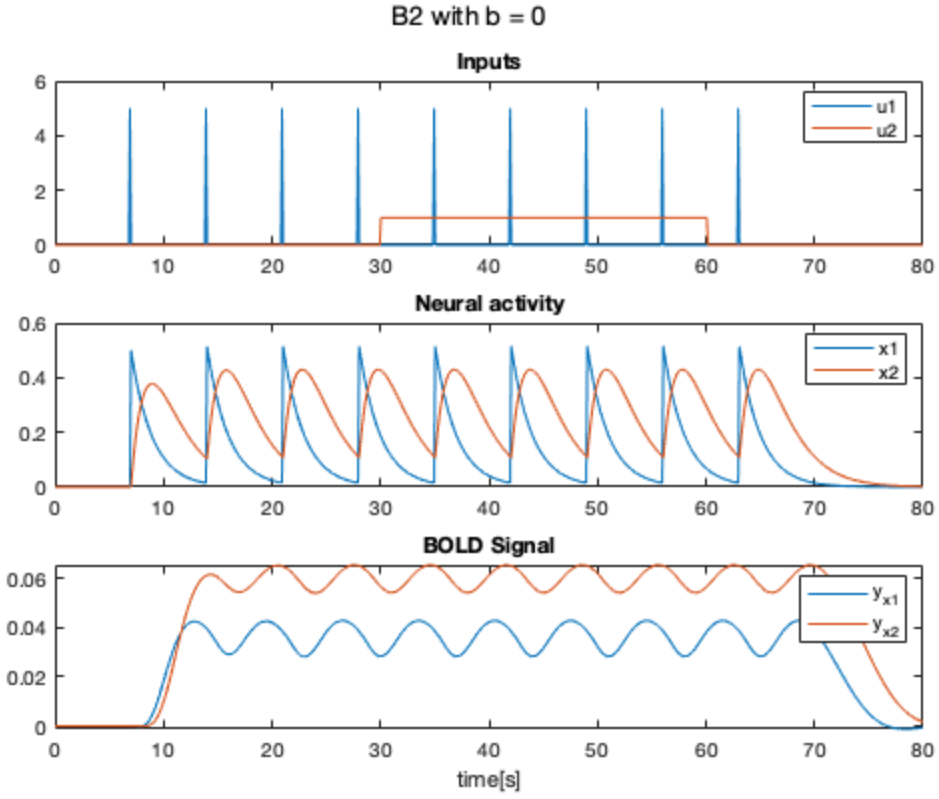
B2

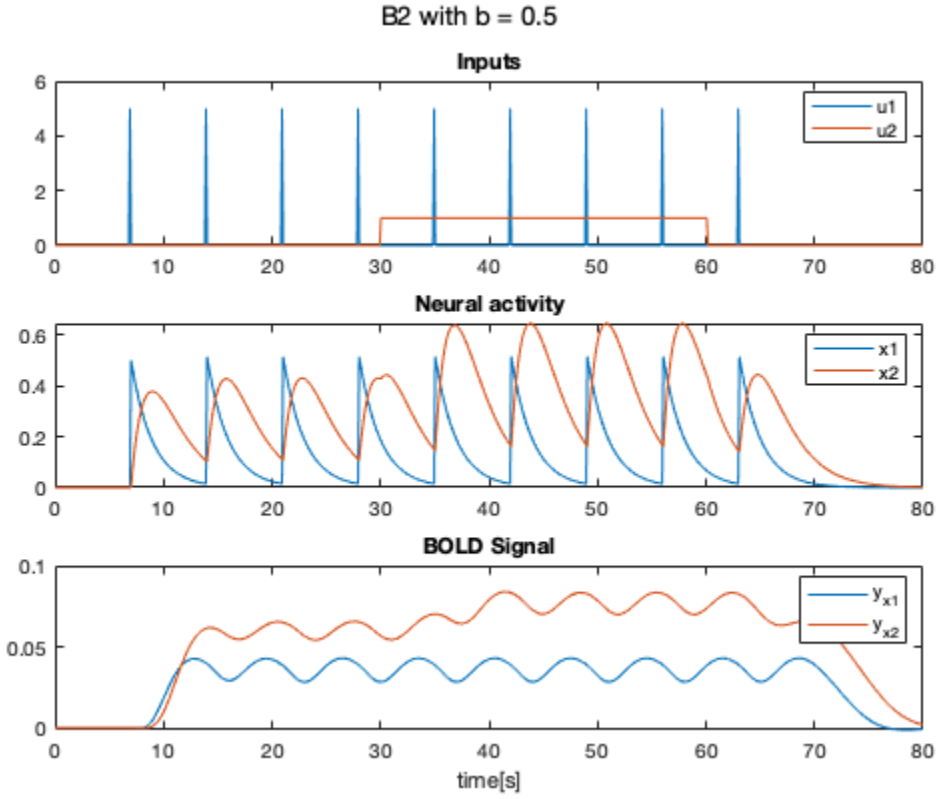
```
%If B = B2, the modulatory input influences the dynamics of the neural
%state x2, linked with the previous state x1. Descriptively we see
 that if b>0, u2>0 has an positive impact on
%x2 (x2 increases) and b<0, u2>0 has a negative impact on x2 (x2
%decreases).
index = 2;
b_vector= linspace(-1,1,5);

for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];

    %construct u
    u_vector = zeros(2,800);
    u_vector(2,301:601)= 1;
    u_vector(1,70:70:631)=5;

    % hrf model construction
```

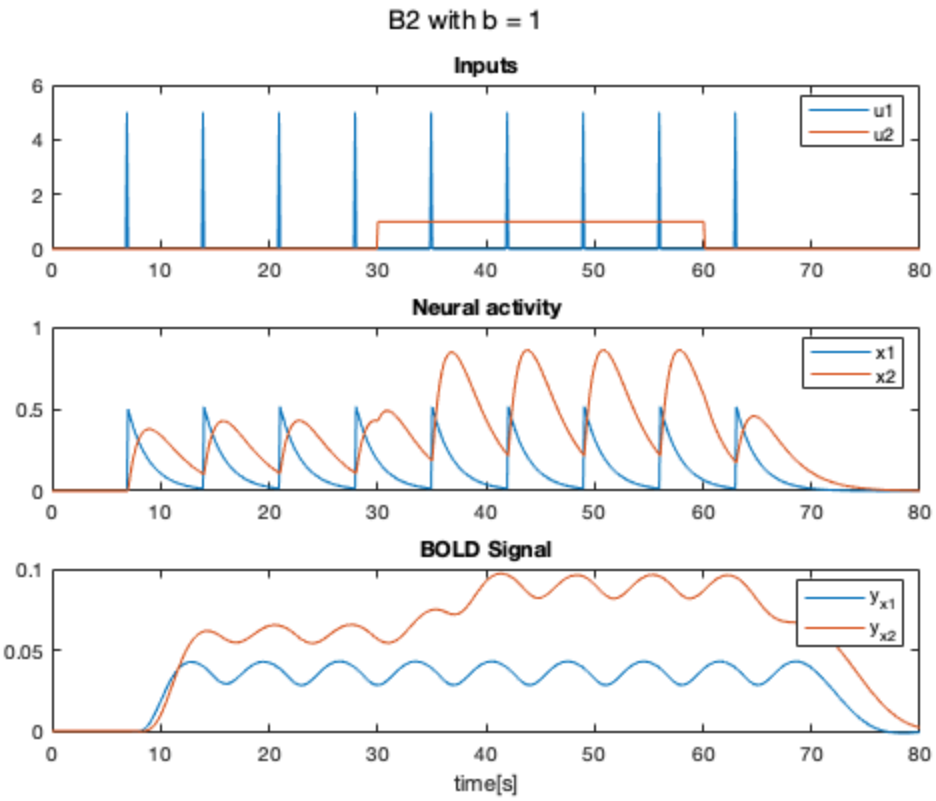
```
    %hemodynamic state vector at t=0 (s,f,v,q)
    h0 = [0;1;1;1];

    % prameters for hrf : kappa, gamma, tau, alpha and E_0
    Phrf=[0.64,0.32,2,0.32,0.4];

    % compute dcm
    [y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);


    % plot results
    t = linspace(0,80,800);
    figure;


    subplot(3,1,1);
    plot(t,u_vector(:,:));
    ylim([0,6]);
    title('Inputs')
    legend('u1','u2')

    subplot(3,1,2);
    plot(t,x(:,:));
    %ylim([0,0.6]);
    title('Neural activity')
    legend('x1','x2')

    subplot(3,1,3);
    plot(t,y(:,:));
    %ylim([0,0.08]);
    title('BOLD Signal')
    legend('y_{x1}','y_{x2}')
    xlabel('time[s]')


    if(index == 1)
        sgtitle(['B',num2str(index)])
        break;
    else
        sgtitle(['B',num2str(index), ' with b =
 ',num2str(b_vector(j))])
    end
end
```


B2 with b = -1
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]


B2 with b = -0.5
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]


B2 with b = 0
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]

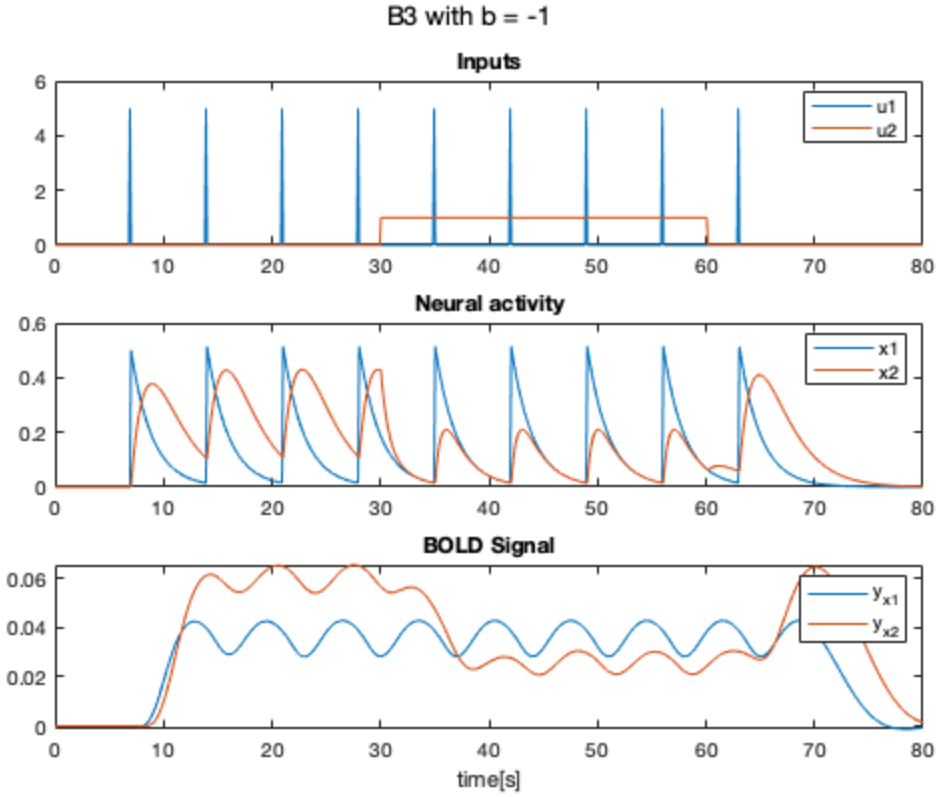

B2 with b = 0.5
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]

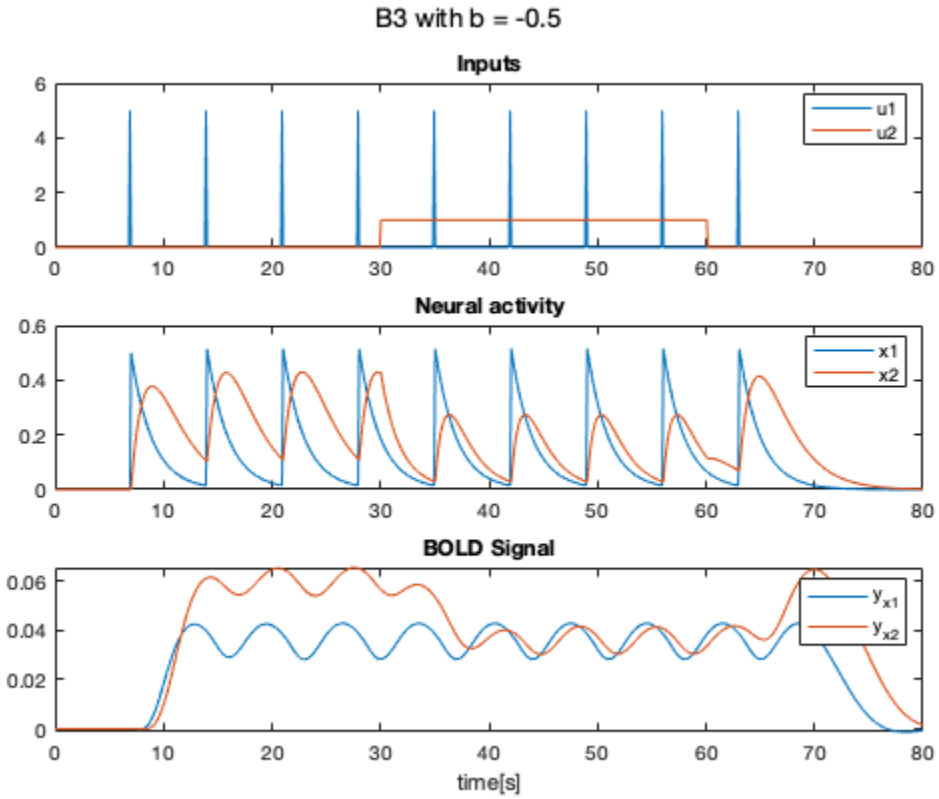


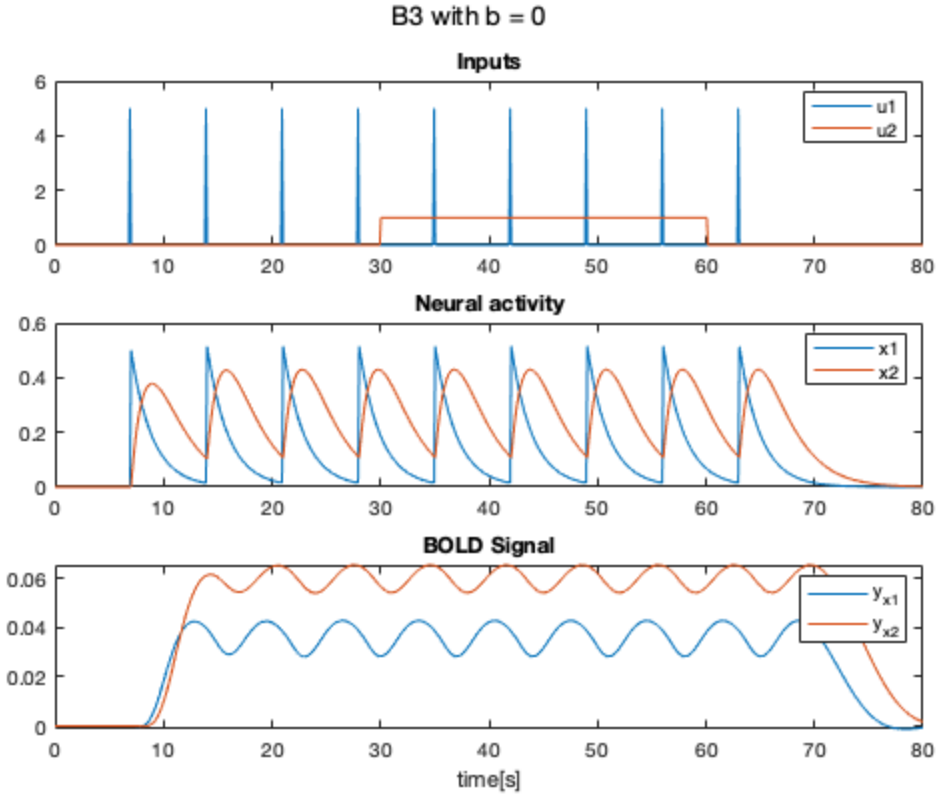
B3

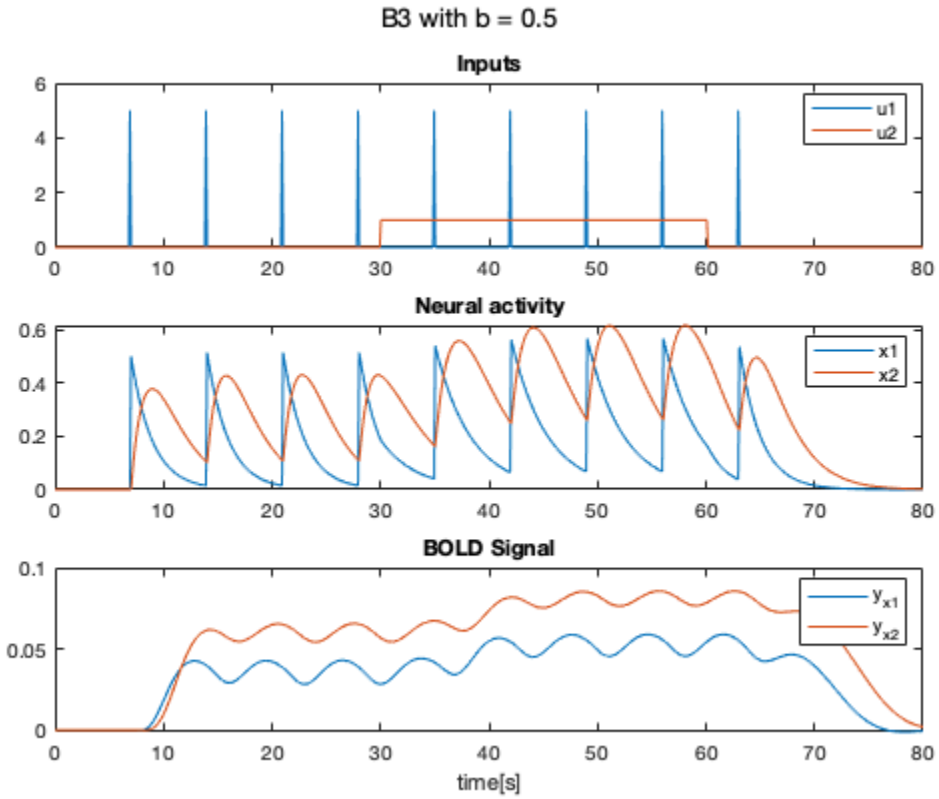
```
%If B = B3, the modulatory input also influences the dynamics of the
 state
%x2, linked with the previous state x2. Descriptively we see that if
 b<0,
%u2>0 has a negative impact on x2 (x2 decreases). If b>0, the positive
 impact of
%u2>0 is changed by setting the diagonal terms of (A+u2B) to
 -0.5exp(aii+u2bii), for the sability of the system.
%This explains the negative impact of b=1 and the reduced positive
 effect
%of b=0.5.
index = 3;
b_vector= linspace(-1,1,5);

for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];
```

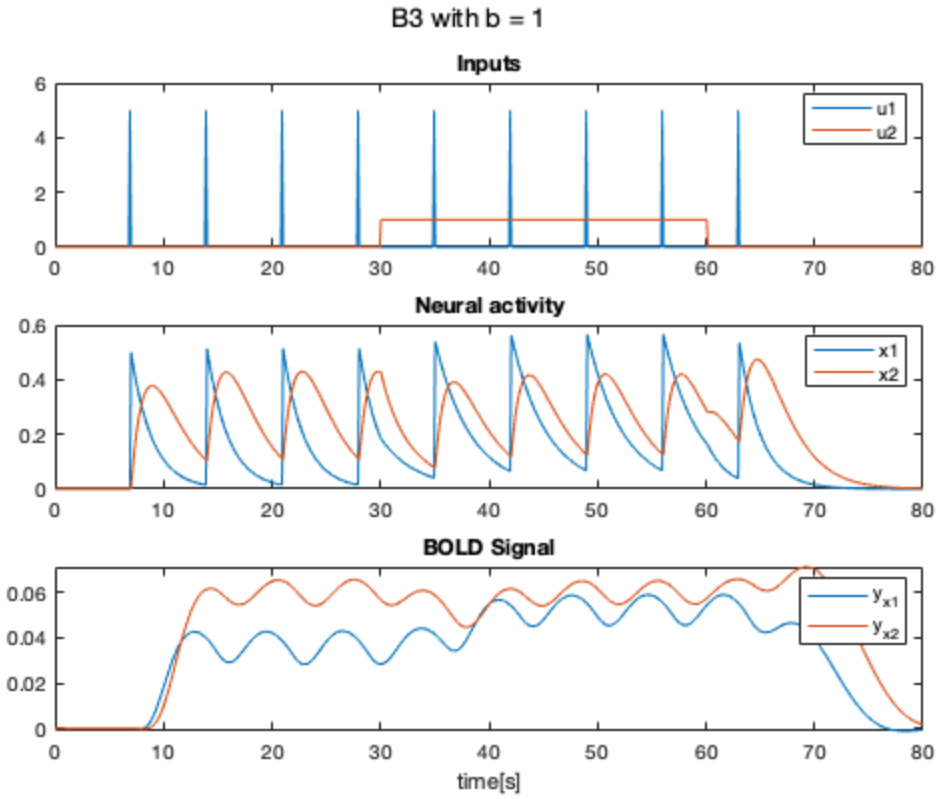
```
    %construct u
    u_vector = zeros(2,800);
    u_vector(2,301:601)= 1;
    u_vector(1,70:70:631)=5;

    % hrf model construction

    %hemodynamic state vector at t=0 (s,f,v,q)
    h0 = [0;1;1;1];

    % prameters for hrf : kappa, gamma, tau, alpha and E_0
    Phrf=[0.64,0.32,2,0.32,0.4];

    % compute dcm
    [y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);


    % plot results
    t = linspace(0,80,800);
    figure;


    subplot(3,1,1);
    plot(t,u_vector(:,:));
    ylim([0,6]);
    title('Inputs')
    legend('u1','u2')

    subplot(3,1,2);
    plot(t,x(:,:));
    %ylim([0,0.6]);
    title('Neural activity')
    legend('x1','x2')

    subplot(3,1,3);
    plot(t,y(:,:));
    %ylim([0,0.08]);
    title('BOLD Signal')
    legend('y_{x1}','y_{x2}')
    xlabel('time[s]')


    if(index == 1)
        sgtitle(['B',num2str(index)])
        break;
    else
        sgtitle(['B',num2str(index), ' with b =
 ',num2str(b_vector(j))])
    end
end
```


B3 with b = -1
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]


B3 with b = -0.5
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]


B3 with b = 0
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]


B3 with b = 0.5
Inputs
u1
u2
Neural activity
x1
x2
BOLD Signal
y_{x1}
y_{x2}
time[s]



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